

**8270 GM-1**

# INTRA-COMPANY CORRESPONDENCE

**To**

At 526

**Date** 7-3-57

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**From**

At 526

**Subject** PRELIMINARY DESIGN SPECIFICATIONS FOR A TWO-MAN AIRSHIP

Ballou, Powers

These specifications are for minimum design conditions:

Speed - 35 mph  
Range - 100 miles  
Altitude - 7,000 ft  
Payload - 400 lbs  
Duration - 3 hrs at cruise speed

The Pony Blimp made by Goodyear in 1917 was of a 35,000 cu ft class with a 3.3:1 fineness ratio. Because of new improved materials and engines, it is expected that an airship could be successfully flown with a volume of only 20,000 ft<sup>3</sup>.

The following data is based on this size a vehicle:

Volume =  $(20,000) \text{ ft}^3 = (.056 \text{ L}^3)$   
 Length = 71 ft  
 Dia. = 24 ft  
 Envelope Weight =  $.0628 W (\text{Vol})^{2/3} = .0628 \times 4 \times (20,000)^{2/3} = 190 \text{ lbs}$   
                     where W = weight of material is oz/sq yd  
 Gross Lift at 7,000 ft = 1,070 lbs  
 Min. Ballonet Vol. = 20 per cent of envelope volume

$$\text{Drag} = C_D \cdot 1/2 \rho (V_{el})^2 (V_{ol})^{2/3}$$

This formula is one that is standard for calculating the drag forces on an airship.

The values for  $C_D$  have been well established by the NACA from wind tunnel tests and actual deacceleration tests on airships. From NACA Report No. 291, the maximum drag coefficient given for a Class "C" envelope with a fineness ratio of 3:1 is .0339. The conclusions in NACA Report No. 394 indicate that "the addition of fins and cars to airship models in the combinations tested increases the drag from 15 to 20 per cent at zero pitch". The data from these two reports indicate that it is likely that the drag coefficient ( $C_D$ ) will be  $.0339 \times 1.20$  or .0406. In NACA Report No. 397 the maximum  $C_D$  given for an airship with a fineness ratio of 3:1 is .044.

For preliminary design, it is felt that a drag coefficient of .050 may be safely used.

The values in the following table have been computed from the above formula using a  $C_D$  value of .040. The horsepower requirements are calculated from the following formula:

$$\text{H.P.} = \frac{(\text{Drag}) (\text{Velocity})}{550 \times \text{Propeller Efficiency}}$$

where the propeller efficiency used is 75 per cent.

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per cent.

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<u>Velocity</u>		<u>Drag at Sea Level</u>	<u>H.P. Required</u>	
<u>mph</u>	<u>ft/sec</u>		<u>Sea Level</u>	<u>7,000 ft</u>
10	14.67	9.38	.334	.27
20	29.33	37.5	2.6	2.1
30	44	84.5	9.0	7.3
40	58.6	150	21.3	17.2
50	73.3	235	41.7	33.7
60	88	338	72	58.3

The theoretical horsepower required at moderate speeds for this unit is quite low. The main difficulty lies in selecting an engine that is sufficiently light.

Barmotive Products of San Leandro, California, manufacture an aluminum alloy engine that has a horsepower rating of 40 and a dry weight of only 45 lbs. Such an engine has a rather high rating for the design conditions of only 35 mph, but it is unlikely that an engine would be available that would be any lighter and yet have the required horsepower.

This engine, Nelson H-56, is designed for airborne operation and has been used in the one-man "flying platform" experimental helicopters and in the Goodyear inflatable wing aircraft.

For a speed of 60 mph, McCulloch manufactures an engine with a rated horsepower of 72 and a dry weight of only 76 lbs. This engine is used for drone target airplanes.

These two engines are both two-cycle air-cooled engines and are rated at 4100 rpm which is not excessive for a two-cycle engine.

The following is a tabulation of probable weights for an airship that would meet the minimum design conditions:

Gross Lift at 7,000 ft altitude	1,070 lbs
Envelope weight	190 lbs
Power plant (propellers, mounts, accessories, etc.), (Nelson H 56)	100
Water ballast (7% gross lift)	75
Personnel	400
Gasoline	90
Gondola and fittings	<u>215</u>
Total	1,070 lbs

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The values in this table are realistic and should not vary much for an airship of this size.

The amount of ballast is calculated from standard operating procedure when the amount of ballast was 4 to 7 per cent of gross load. Ninety pounds of gasoline would last for 3-1/3 hours with the engine operating at rated horsepower. This would provide a range of approximately 160 miles.

The need for an adequate material for its construction is the greatest deterrent in building this airship. Work is presently being carried on with the film companies to develop a light, strong, gas-tight material. The goal at the present is to laminate a Fortisan cloth with polyethylene to make a film that can be fabricated using present or improved heat-sealing techniques. With minor changes in the presently available Fortisan-poly laminate, it is expected that a material suitable for this model may be fabricated.

More preliminary design work has to be done on an internal catenary suspension system to attach the control car and power plant to the envelope of the system.

Within a reasonably short period it is expected that an airship such as described can be constructed.

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